



Application No. 10/827,097

Amendment and Response Dated April 12, 2005

Reply to Office Action dated January 13, 2005

Listing of Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (currently amended) A method of ink jet printing ~~[[with]]~~ UV curable ink on a substrate that may be formed of a heat sensitive rigid or other material, the method comprising:

moving a printhead carriage having an ink jet printhead thereon approximately parallel to a substrate;

jetting ink from the heads across the predetermined distance onto the surface of a substrate;

providing at least one cold UV curing assembly on the carriage oriented to direct UV energy onto the surface of the substrate sufficiently close to where ink is being jetted onto the surface so as to freeze dots of the jetted ink on the surface; and

the cold UV assembly being effective to impinge sufficient UV ~~[[light]]~~ energy on the jetted ink to substantially cure the jetted ink ~~[[while]]~~ without impinging radiation of other wavelengths that would heat the substrate so as to deform it.

Claims 2-8 (canceled)

9. (currently amended) An ink jet printing apparatus for printing with UV curable ink on ~~three-dimensional surfaces of a substantially rigid substrate~~~~[[s]]~~ having a tendency to deform toward the printhead when heated, the apparatus comprising:

a substrate support defining a substrate supporting plane;

a printhead track extending parallel to the plane having a printhead carriage moveable thereon;

at least one ink jet printhead on the carriage;

at least one cold UV curing head on the carriage sufficiently close to the ink jet printhead to freeze dots of ink in position on the substrate when jetted thereon from the printhead;

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the UV curing head being configured to emit sufficient UV energy to at least partially cure the ink jetted onto the substrate without heating and thermally deforming the substrate ~~when formed of a heat deformable material.~~

Claims 10-11 (canceled)

12. (currently amended) The apparatus of claim ~~[[11]]~~ 9 wherein:

the at least one UV curing head includes at least two cold UV curing heads, one positioned on the carriage at each side of the printheads so that one leads the printheads and one trails the printheads as the carriage moves on in either of two opposite directions on the track; and

the controller is operable to activate at least ~~the trailing~~ one of the UV curing heads to expose the ink jetted by the printheads on the surface of the substrate ~~in the same pass of the carriage over the surface in which the ink being exposed was jetted.~~

Claim 13 (canceled)

14. (currently amended) The apparatus of claim ~~[[11]]~~ 9 further comprising:

a heating station positioned so as to heat UV light exposed ink on a substrate.

15. (previously presented) The apparatus of claim 14 wherein:

the heating station includes a blower oriented to direct heated air onto a substrate on the support.

Claims 16-18 (canceled)

19. (new) An ink jet printing apparatus for printing UV curable ink on substrates, the apparatus comprising:

- a substrate support;
- a printhead carriage moveable substantially parallel to the support;
- at least one ink jet printhead on the carriage directed toward the support;
- at least one UV curing head on the carriage sufficiently close to the ink jet printhead to at least partially cure ink when jetted onto a substrate on the support;
- the UV curing head being configured to emit UV energy to at least partially cure the ink jetted onto the substrate without deforming the portion of the substrate on which ink is being jetted.

20. (new) The apparatus of claim **19** wherein the substrate is foamboard.

21. (new) The apparatus of claim **19** wherein the UV curing head includes:

- a UV energy source;
- a filter configured to limit substrate-heating radiation from the source onto the substrate.

22. (new) The apparatus of claim **19** wherein the UV curing head includes:

- a UV energy source;
- a mirror configured to limit substrate-heating radiation from the source onto the substrate.

23. (new) The apparatus of claim **19** wherein the UV curing head includes:

- a UV energy source;
- a fluid cooling system configured to remove heat from the UV curing head.

24. (new) The apparatus of claim **23** wherein the fluid cooling system includes a cooling liquid.

25. (new) The apparatus of claim **19** wherein the substrate is foamboard, and the UV curing head includes:

- a UV energy source;
- a radiation filter configured to limit substrate-heating radiation from the UV energy source onto the foamboard; and
- a fluid cooling system configured to conduct heat away from the UV curing head.

26. (new) The apparatus of claim **25** wherein:

- the radiation filter includes a mirror; and
- the fluid cooling system is configured to remove heat from the mirror.

27. (new) A method of dispensing UV curable ink from a printhead onto a substantially rigid substrate formed of a material that has a tendency to deform at least temporarily if exposed to radiant energy, the method comprising:

- moving a printhead approximately parallel to a substrate at a printing station;
- dispensing ink from the printhead onto a surface of the substrate; and
- providing at least one cold UV curing assembly moveable with the printhead and configured to direct UV radiation onto the surface of the substrate to freeze the dispensed ink on the surface of the substrate and to substantially cure the ink without impinging radiation that would materially deform the substrate while the substrate is at the printing station.

28. (new) The method of claim **27** wherein:

- the cold UV curing assembly is effective to substantially cure the jetted ink without impinging radiation of non-UV wavelengths that would substantially deform the surface of the substrate where the ink is being jetted while ink is being jetted onto the surface of the substrate.

29. (new) A method of dispensing UV curable ink from a printhead onto a substantially rigid substrate formed of a material that has a tendency to deform at least temporarily if exposed to radiant energy, the method comprising:

- moving a printhead approximately parallel to a substrate at a printing station;
- jetting UV curable ink from the printhead onto a surface of the substrate at the printing station; and
- directing UV energy onto the surface of the substrate at the printing station while filtering the energy being directed onto the substrate at the printing station and removing heat by fluid flow from the proximity of the substrate at the printing station.

30. (new) The method of claim **29** wherein:

- the jetting of UV curable ink includes moving an ink jet printhead in the vicinity of the substrate at the printing station;
- the directing of UV energy onto the surface of the substrate at the printing station includes impinging UV energy onto the jetted ink on the substrate at the printing station sufficient to at least partially cure the ink; and
- the filtering of the energy includes using a mirror to limit energy onto the substrate.

31. (new) An ink jet printing apparatus for printing upon a substrate, the ink jet printing apparatus comprising:

- a printhead carriage;
- a printhead coupled to and movable with the printhead carriage to different positions with respect to the substrate; and
- a cold UV curing head configured to direct an amount of UV energy toward the substrate, the amount of UV energy sufficient to at least partially cure ink dispensed from the printhead upon the substrate, but insufficient to substantially thermally deform the substrate.

32. (new) The apparatus of claim **31** wherein:

the substrate is foamboard.

33. (new) The apparatus of claim **31** wherein the substrate is foamboard and the apparatus further comprises:

a substrate support table having vacuum ports therein and a vacuum system coupled to the ports and configured to clamp a foamboard to the table.

34. (new) The apparatus of claim **31** wherein the cold UV curing head includes a limited bandwidth UV source.

35. (new) The apparatus of claim **31** wherein the cold UV curing head comprises:

at least one lamp fixed relative to the printhead that emits UV light;

a reflector having a surface configured to direct UV light onto the substrate from behind the at least one lamp; and

a fluid cooling system coupled to the reflector.

36. (new) The apparatus of claim **35** wherein the cold UV curing head further comprises:

a hollow tube, substantially transparent to UV radiation, substantially absorbent of infrared radiation, and formed of a temperature and radiation tolerant material, the tube extending the length of the head and being positioned between the at least one lamp and the substrate.

37. (new) The apparatus of claim **36** wherein the cold UV curing head further comprises:

a second fluid cooling system coupled to the tube to remove heat energy from infrared radiation by the tube.

38. (new) The apparatus of claim **31** wherein the cold UV curing head comprises:

at least one lamp fixed relative to the printhead that emits UV light;

the at least one lamp consuming power of at least approximately 125 watts per linear inch.

- 39. (new)** The apparatus of claim **31** wherein the cold UV curing head comprises:
- at least one lamp fixed relative to the printhead that emits UV light;
 - the at least one lamp being capable of being operated at a power consumption of at least 200 watts per linear inch.
- 40. (new)** The apparatus of claim **31** wherein the cold UV curing head comprises:
- at least one lamp fixed relative to the printhead that emits UV light;
 - a reflector having a surface configured to direct UV light onto the substrate from behind the at least one lamp; and
 - a fluid cooling system coupled to the reflector.
- 41. (new)** A method of ink jet printing upon a deformable substrate, the method comprising:
- positioning a deformable substrate relative to a printhead for printing thereon;
 - moving a printhead with respect to the deformable substrate;
 - dispensing ink from the moving printhead onto the positioned deformable substrate; and
 - exposing the ink dispensed onto the deformable substrate to UV energy of an amount sufficient to at least partially cure the ink upon the deformable substrate without thermally deforming portions of the deformable substrate upon which ink is being dispensed.
- 42. (new)** The method of claim **41** wherein:
- the exposing of the ink dispensed onto the deformable substrate includes exposing the ink to UV energy sufficiently close to the printhead to retard movement of the ink on the substrate.
- 43. (new)** The method of claim **42** wherein:
- the exposing of the ink takes place on the portions of the deformable substrate which, if deformed by the UV energy, would change the position of the substrate as ink is being dispensed thereon.
- 44. (new)** The method of claim **41** wherein the substrate is foamboard.

45. (new) An ink jet printing apparatus for printing upon a deformable substrate, the apparatus comprising:

a printhead carriage;

a printhead coupled to and movable with the printhead carriage to different positions with respect to the deformable substrate;

a substrate support table configured to support the deformable substrate for printing thereon by the printhead; and

a cold UV curing head on the carriage configured to direct UV energy toward the substrate;

the cold UV curing head including at least one lamp having a power consumption of at least approximately 125 watts per linear inch.

46. (new) The apparatus of claim **45** wherein the cold UV curing head further comprises:

a hollow tube, substantially transparent to UV radiation, substantially absorbent of infrared radiation, and formed of a temperature and radiation tolerant material, the tube extending the length of the head and being positioned between the at least one lamp and the substrate; and

a second fluid cooling system coupled to the tube to remove heat energy from infrared radiation by the tube.

47. (new) The apparatus of claim **45** wherein the cold UV curing head comprises:

at least one lamp includes two lamps, one on each side of the printhead that emit UV light of at least 200 watts per linear inch.

48. (new) The apparatus of claim **45** wherein the substrate table has vacuum ports therein and a vacuum system coupled to the ports and configured to clamp a deformable substrate to the table.

49. (new) The apparatus of claim **45** wherein the substrate is foamboard.